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April 3, 1990

Milton M. Beck, D.V.M.
State of Delaware
Department of Natural Resources and
Environmental Control
715 Grantham Lane
New Castle, DE 19720

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DNREC SUPER FUND BRANCH

Subject: April 1990 Groundwater Sampling
Chem-Solv, Inc. Site, Cheswold, Delaware
BCM Project No. 00-6012-02

Dear Dr. Beck:

The purpose of this letter is to submit proposed revisions to the groundwater sampling event scheduled for April 1990. This letter serves as an addendum to the Remedial Investigation/Feasibility Study Work Plan (Work Plan) for the Chem-Solv, Inc. (Chem-Solv) Site submitted by BCM Engineers Inc. (BCM) to the State of Delaware Department of Natural Resources and Environmental Control (DNREC) in October 1989 and approved December 1, 1989.

This addendum will address two issues: the selection of alternate monitoring wells to be sampled during the April 1990 groundwater sampling event and alterations/revisions to groundwater sampling protocol contained in the Chem-Solv Quality Assurance Project Plan (QAPjP).

Selection of Alternate Monitoring Wells

The groundwater investigation described in Section 4.5 of the Work Plan includes a groundwater sampling event. Thirteen monitoring wells, including the seven wells installed by BCM as part of the Remedial Investigation, and the inactive recovery system are to be sampled and analyzed for Target Compound List organic compounds and Target Analyte List inorganic compounds (Table 1). However, monitoring well 28A, which was located along the southwestern edge of the Gearhart property, was paved over when the existing driveway was repaved (Figure 1). Therefore, an alternate well will have to be sampled in place of well 28A. In our March 21, 1990, telephone conversation, monitoring wells 24A, 25A, 27A, 41A, and 42A were discussed as potential alternate sampling locations for well 28A.

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Since wells 24A, 25A, 27A, and 41A could not be located during the recent field investigation activities, it was necessary to attempt to locate the wells with a magnetometer.

On March 26, 1990, BCM used a magnetometer to locate monitoring wells 24A, 25A, and 39A, that are located in the Route 13 median, just south of the intersection of Routes 13 and 42. All three wells were located. In addition, wells 27A and 41A, which are located on either side of well 28A, were located. However, the outer casing for well 27A has been destroyed and subsequently the well is partially plugged with sediment and cannot be sampled. Therefore, BCM recommends well 41A be sampled as replacement for well 28A since it is located downgradient of the site and is in the direct path of the determined groundwater flow direction.

Revisions to Groundwater Sampling Protocol

A general description of the groundwater sampling event, including a list of the monitoring wells to be sampled and the analytical parameters, is contained in Section 4.5.5 of the Work Plan. Section 4.3 of the QAPJP (Appendix B of the Work Plan) contains the detailed specifications for groundwater sampling. Revisions to specific sections of the QAPJP are underlined in the following paragraphs.

Section 4.3.3, item 3.

"Each well will be purged of three to five times the volume of standing water in the well with a centrifugal pump, a peristaltic pump, or a PVC or Teflon bailer. During pumping, the suction hose will be lowered into the top of the water column so that groundwater is pumped from the entire water yielding interval. To verify adequacy of purging, up to five volumes of standing water in the well will be pumped until specific conductivity, temperature, and pH of the groundwater stabilize. If well yield does not sustain continuous pumping, the well will be pumped or bailed dry once. The suction hose will be removed from the well while the pump is running to prevent backflow into the well."

Section 4.3.3, item 4.

"Where possible, the sample will be bailed from the entire depth of the well and placed in appropriate laboratory-prepared sample containers. Due to the small inner diameter (5/8 inch) of many of the existing wells, groundwater samples from wells 22A, 26A, 39A, and 41A will be obtained using a peristaltic pump with Teflon tubing. Samples for volatile organic analyses will be collected from the first bailer of water and preserved as outlined in Section 4.3.3.3. Samples for metals analyses will be collected as filtered and unfiltered samples. Filters used in the

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nitrogen pressurized stainless steel filtration apparatus will be pre-rinsed using demonstrated analyte-free water and then pre-rinsed with a portion of the sample prior to filtration of the actual sample."

Section 4.3.3, item 5.

"The sampling process, using either a bailer or a peristaltic pump with Teflon tubing, will continue until the required volume of sample is obtained."

Section 4.3.3, item 6.

"The sample containers will then be rinsed, labeled, and placed in a chilled environment (4°C) for shipment to the Industrial and Environmental Analysts, Inc. laboratory in Cary, North Carolina."

Section 4.3.3.2, paragraph 1, Using Pumps to Purge.

"If peristaltic or centrifugal pumps are used, only the intake line will be placed into the water column. To minimize contamination, the line placed into the water will be either Teflon, when using the peristaltic pumps, or polyethylene, when centrifugal pumps are used. The peristaltic pump will use 1/4-inch diameter Teflon tubing. Since Teflon tubing is very rigid, it can not be used inside the peristaltic pump; a 6 inch long length of 1/4-inch diameter silicon tubing will be used inside the pump assembly. Teflon fittings will be used to connect the silicon and Teflon tubing. Prior to insertion into the well, the Teflon or polyethylene tubing will be decontaminated in accordance with the procedures outlined in Section 4.1.2, unless dedicated tubing is used for each well."

Section 4.3.3.3, paragraph 1.

"Special sample handling procedures will be instituted when trace contaminant samples are being collected. All sampling equipment, including pumps, bailers, drilling equipment, water level measurement equipment, etc., which come into contact with the water in the well must be cleaned in accordance with the cleaning procedures described in Section 4.1.2. Electric water level indicators will be cleaned with soap and an analyte-free water rinse only since the solvents included in the standard cleaning procedure may damage the probe. Pumps will not be used for sampling unless the well has dedicated in-place plumbing."

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pump or the well diameter is too small for a bailer to be used. For wells with small diameters, a peristaltic pump with Teflon tubing will be utilized for sampling."

Section 4.3.3.3, Volatile Organics Sampling, paragraph 3.

"When collecting water samples for volatile organics, three 40-ml vials will be collected from each location. In accordance with current USEPA Region III requirements, the volatile organics samples will be preserved with 1:1 hydrochloric acid (HCl) to a pH less than 2.0 to extend the analytical holding time. To determine the proper amount of HCl needed at each location to preserve the sample, one 40-ml vial will be filled with ground-water obtained as the well is purged prior to sampling; the sample will be obtained after specific conductivity, temperature, and pH have stabilized during the purging process. HCl will be added dropwise to the vial. The vial will be capped and shaken, reopened, and the pH will be measured with pH test paper (strips) by touching the water on the inside of the cap. Upon determination of the number of drops required to achieve the proper pH, the test vial will be discarded. The remaining two vials will be acidified (with the same number of drops of HCl) immediately upon collection of the first bailer from each well. The method of using purge water to determine the number of drops of HCl needed to preserve the sample allows the volatile sample to be obtained immediately from the first bailer as the well is sampled."

If you have any questions or comments regarding this addendum, please contact us immediately.

Very truly yours,

Margaret E. Bonaker

Margaret E. Bonaker
Geologist

Mary M. Mang

Mary M. Mang
Assistant Vice President

/bvt 7355q
Enclosures

cc: M.C. Hwang, Miles and Stockbridge
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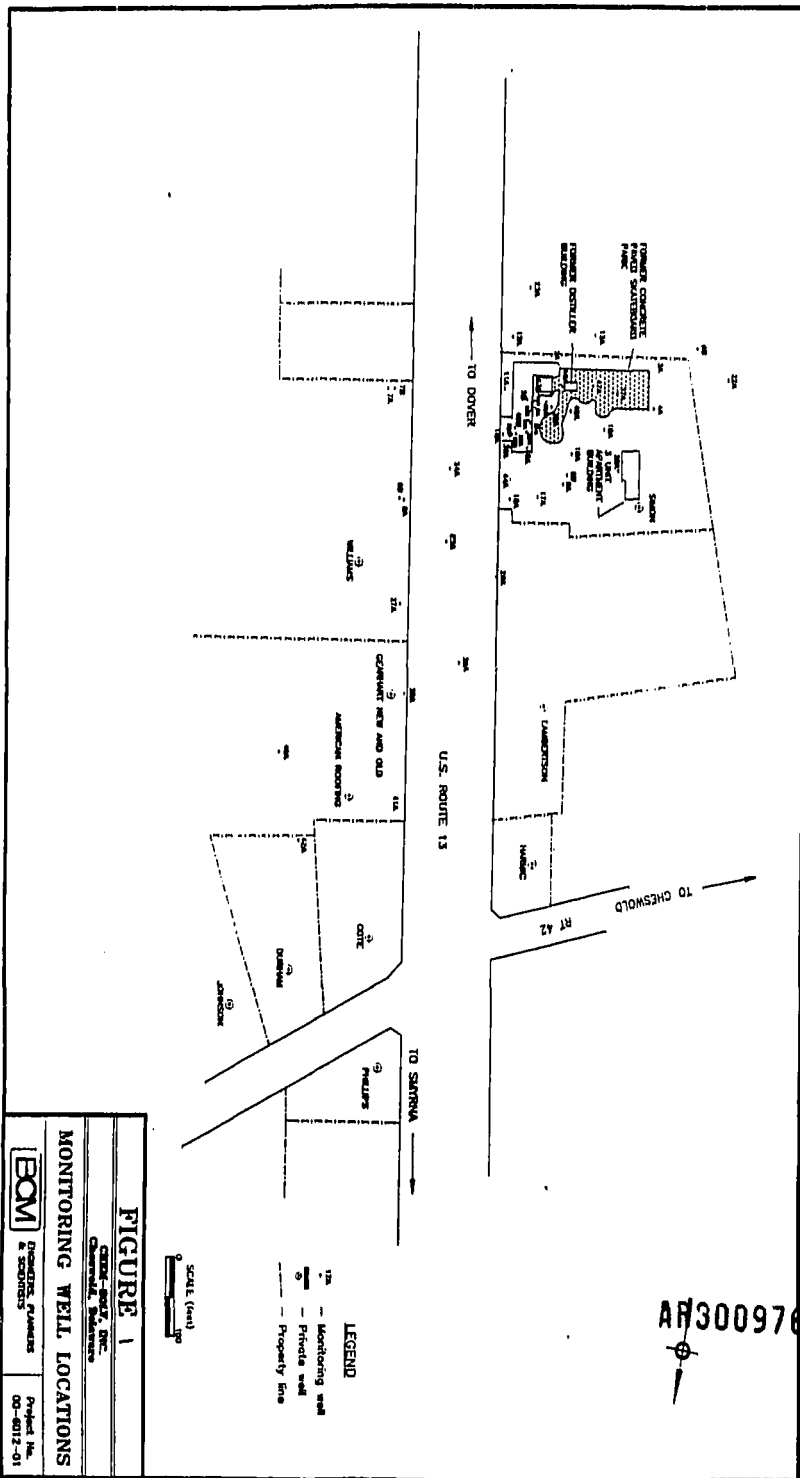
TABLE 1
GROUNDWATER SAMPLING INVESTIGATION
CHEM-SOLV, INC. SITE RI/FS
CHESWOLD, DELAWARE

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WELL	WELL DIAMETER (inches)	PURGE METHOD	SAMPLE METHOD	ANALYTICAL PARAMETERS
22A	5/8	PERISTALTIC PUMP	PERISTALTIC PUMP	TCL ORGANICS; TALINORGANICS
26A	5/8	PERISTALTIC PUMP	PERISTALTIC PUMP	TCL ORGANICS; TALINORGANICS
39A	5/8	PERISTALTIC PUMP	PERISTALTIC PUMP	TCL ORGANICS; TALINORGANICS
41A	5/8	PERISTALTIC PUMP	PERISTALTIC PUMP	TCL ORGANICS; TALINORGANICS
5B	1.5	CENTRIFUGAL PUMP	TEFLON BAITER	TCL ORGANICS; TALINORGANICS
9B	4	CENTRIFUGAL PUMP	TEFLON BAITER	TCL ORGANICS; TALINORGANICS
RECOVERY SYSTEM	NA	IN-PLACE PUMP	IN-PLACE PUMP	TCL ORGANICS; TALINORGANICS
MWL-1-43	2	CENTRIFUGAL PUMP	TEFLON BAITER	TCL ORGANICS; TALINORGANICS
MWL-2-40	2	CENTRIFUGAL PUMP	TEFLON BAITER	TCL ORGANICS; TALINORGANICS
MWS-3-17	2	CENTRIFUGAL PUMP	TEFLON BAITER	TCL ORGANICS; TALINORGANICS
MWL-4-40	2	CENTRIFUGAL PUMP	TEFLON BAITER	TCL ORGANICS; TALINORGANICS
MWS-5-18	2	CENTRIFUGAL PUMP	TEFLON BAITER	TCL ORGANICS; TALINORGANICS
MWS-6-25	2	CENTRIFUGAL PUMP	TEFLON BAITER	TCL ORGANICS; TALINORGANICS
MWS-7-25	2	CENTRIFUGAL PUMP	TEFLON BAITER	TCL ORGANICS; TALINORGANICS

NA Not applicable
TCL Target Compound List
TAL Target Analyte List

Source: BCM Engineers Inc. (BCM Project No. 00-6012-02)



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TRANSMITTAL LETTER

TO Milton M Beck, DVM

DATE 3 April, 1990

Delaware Dept. of Natural Resources and Environmental Control

715 Grantham Lane

New Castle, DE 19720

PROJECT Chem-Solv RI/FS, Cheswold DE

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REMARKS _____

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III

101 Chestnut Building
Philadelphia, Pennsylvania 19107

SUBJECT: Guidance on Handling and Reporting
Chemical Concentration Data in
Superfund Risk Assessments

DATE: December 13, 1989

FROM: Roy L. Smith
Debra L. Forman
Richard L. Brunker
Dawn A. Ioven
Toxicologists

TO: Superfund RPMs and Peer Reviewers

THROUGH: John A. Armstead, Chief
Technical Support Section (JAW15)

Many Superfund risk assessments incorporate improper data reporting and handling. Common errors include (1) omission of limits of detection and quantitation, (2) unjustified treatment of non-detects as zero, and (3) incorrect averaging based on incorrect combining of sample data and unsupported statistical assumptions. These errors have led to inconsistent, and (some cases) inaccurate risk assessments. Past attempts to repair these errors in individual reports have done little to reduce their frequency.

Attached are Region III guidelines containing technically correct methods of reporting and interpreting data, intended for use in Superfund risk assessments. The ultimate goals are improved accuracy and consistency, and reduced uncertainty, of these risk assessments.

The guidance addresses four topics:

- > *Reporting data below the limits of detection.* The proposal suggests specific formats for reporting analytical results, especially non-detects. All data tables should include limits of detection (LOD), limits of quantification (LOQ), and definitions for the LOD and LOQ, relating to each individual data set.
- > *Calculating most probable exposure and plausible upper bound exposure.* These exposure calculations should be based on the statistical distribution of the concentration data. The guidance specifies default calculations where statistical analysis is not possible.
- > *Calculating averages.* Calculations of average exposure should attempt to estimate typical long-term exposure to target populations. Persons upgradient of sites are

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presumed not to be exposed, and are not a target population. Thus, combining up- and down-gradient concentrations in the same average is incorrect.

- > *Averaging with non-detects.* Where a contaminant could reasonably be present below the limit of detection (LOD), it should be treated as present at $\frac{1}{2}$ the LOD for the purpose of averaging. The guidance includes a simple decision path to determine whether the contaminant could reasonably be present.

Please provide a copy of this guidance to your contractors, and to anyone else who may need it. In accordance with Region III's policy of using best science in risk assessments, future risk assessments should adhere to these practices or defend the use of alternate methods.

Attachment

cc: Abraham Ferdas (3HW20)
Patrick Anderson (3HW21)
Walter Graham (3HW22)
Roy Schrock (3HW23)
Bill Hagel (3HW24)
Laura Boornazian (3HW25)

Steven Hirsh (3HW26)
Richard Dulcey (3HW12)
Ben Mykijewycz (3HW13)
Peter Schaul (3HW10)
Robert Greaves (3HW60)

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**EPA Region III Guidance on
Reporting and Handling of Chemical Concentration Data
in Exposure Assessments**

December 13, 1989

The goal of this guidance is to reduce uncertainty, caused by incorrect reporting and analysis of chemical data, in Region III Superfund risk assessments. These recommendations cover four topics:

- (1) Reporting data near the detection limit;
- (2) Estimating upper bound and most probable exposures;
- (3) Selecting observations to include in averages; and
- (4) Including non-detects in averages.

An appendix to the guidance contains excerpts from draft EPA proposed *Guidelines for Exposure-Related Measurements*, which are new additions to the Agency's Risk Assessment Guidelines expected to be finalized early in 1990. These guidelines have served as the basis for the specific recommendations for Region III Superfund risk assessments. Questions should be addressed to any of the Region III Superfund toxicologists.

I. Reporting Data Near the Limit of Detection (LOD)

Superfund risk assessments generally include data summary tables which report non-detects as blanks and provide no information on limits of detection (LODs) or quantitation (LOQs). This practice is equivalent to data censoring, and is strongly discouraged. All tables reporting individual concentration data (including summary tables) should use the following rules:

1. Each data summary table should include separate columns for analyte-specific LODs and LOQs. For GC/MS data, generic estimates of LODs may be used, if available. If no LOD estimates are available for GC/MS data, the LOD information may be omitted.
2. Each report should include definitions of the LOD and LOQ for each set of data.
3. Where the measured value is less than the LOD, report a blank with the code "U", meaning the analyte was not detected. If LODs vary among individual samples, report the LODs (instead of blanks) with the code "U". For GC/MS data lacking LODs, report the LOQ with "U".
4. If the measured value is larger than the LOD but smaller than the LOQ, report the estimated concentration and the code "J".

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meaning detected but not quantifiable. (Use of this format is already common, and should continue.)

5. If the measured value is greater than the LOQ, report the value without "U" or "J" codes.

The following example formats are recommended.

- a. All LODs and LOQs are the same:

LOD (µg/l)	LOQ (µg/l)	Compound	Concentration in groundwater (µg/l)	
			Sample 1	Sample 2
0.3	1.0	trichloroethene	U	1.5
0.1	0.5	vinyl chloride	0.3 J	U
0.1	0.5	tetrachloroethene	5.5	0.4 J

- b. LODs and LOQs vary among samples:

Compound	Concentration in groundwater (µg/l)	
	Sample 1	Sample 2
trichloroethene	0.3 U	10 U
vinyl chloride	0.3 J	20 J
tetrachloroethene	0.1 U	5 U

C. Definitions:

U: concentration below limit of detection (LOD); number shown is the LOD.

J: estimated concentration below limit of quantitation (LOQ); number shown is an estimated concentration.

Definition of LOD: e.g., 3 standard deviation units above the mean value of the blank responses.

Definition of LOQ: e.g., 10 standard deviations above the mean value of the blank responses.

II. Calculating Upper Bound and Most Probable Estimates of Chemical Concentrations

Estimates of most probable and plausible upper bound chemical concentrations should be based on analyses of the frequency distributions of the data, whenever the database is sufficient to support such analyses. Use of statistical tests comparing the distribution of the observed data with the normal (or some other frequency distribution) is preferred. The use of frequency distribution graphs of the data, without statistical test results, may be acceptable for some data sets.

If the analysis shows the data are not normally distributed, they should be transformed to normality, if possible. After data are normalized, either the 90% upper confidence limit (equal to the 95th percentile) or the maximum, whichever is less, should be used as the plausible upper bound concentration. This allows the exposure assessor to select a less-than-maximum concentration as a plausible upper bound if the database is of high quality. The arithmetic mean of the normalized data should be used as the most probable concentration. Note that if raw data are log-normally distributed, the arithmetic mean after normalization equals the geometric mean of the raw data.

In the absence of frequency distribution analysis, the maximum concentration should be used as the plausible upper bound and the arithmetic (not geometric) mean should be considered the most probable concentration. Geometric means (which are less than or equal to arithmetic means) should not be used unless analysis of the frequency distribution shows they are appropriate.

III. Selecting Observations to Include in Averages

The exposure assessor should ensure that adequate background control samples are included in RI/FS work plans. When reviewing RI/FS sample data, the assessor must have a clear idea which samples were controls and which were taken to characterize the site. Examples of control samples include those from upgradient groundwater wells (assuming gradients have been measured), upstream surface water or sediment locations, and soil samples far enough from the site that contamination is unlikely.

It is incorrect to compute averages which include both control and site samples when estimating most probable exposure, because:

1. Averages which mix site and background samples have no meaning to the exposure assessment. The most probable exposure should represent a typical concentration contacted by an exposed individual. Persons who contact only control areas (e.g., users of upgradient wells) are assumed not to be exposed to contaminants from the site.
2. Averages which mix site and background samples are biased. If background levels are high, an average which includes control samples is biased high; if background levels are low, an average which includes control samples is biased low.

The purpose in collecting background samples is to support a comparison of site-influenced means with control sample means. Only this type of comparison allows the exposure assessor to distinguish site-related exposure from background exposure. If possible, these comparisons should be done statistically, especially if background concentrations are high.

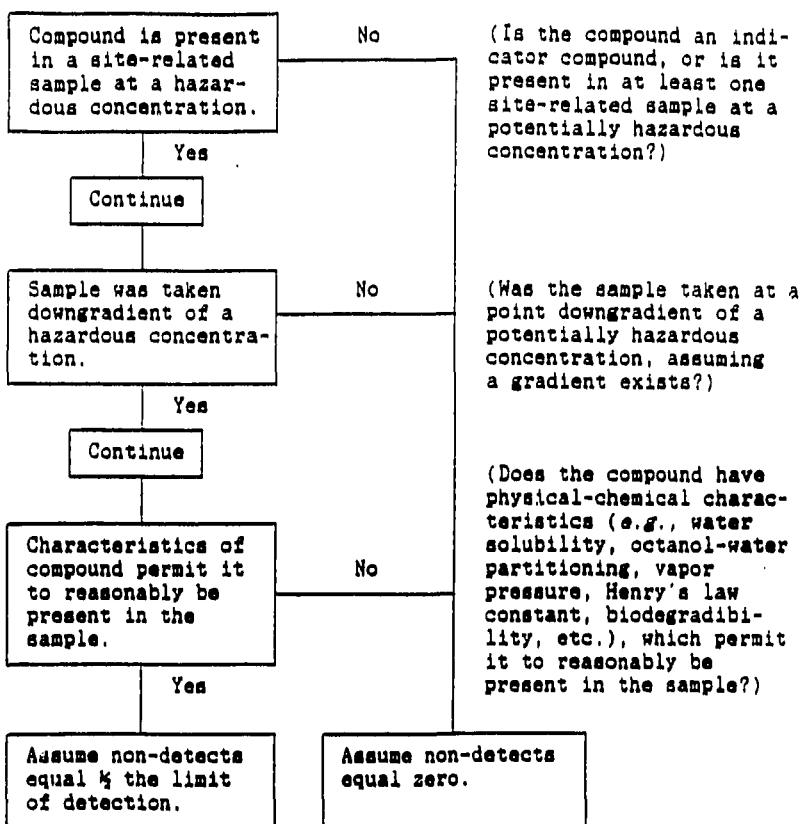
IV. Calculating Averages Which Include Non-Detects

Exposure assessors may encounter any of the following methods of treating non-detects:

1. Non-Detects reported as LODs - In this worst-case approach, all non-detects are assigned the value of the LOD, the largest concentration of analyte that could be present but not yet detected.
2. Non-Detects reported as zero - This is the best-case approach, in which all undetected chemicals are assumed totally absent.
3. Non-Detects reported as half the LOD - This approach assumes that on the average all values between the LOD and zero could be present. Therefore, the average value of non-detects could be as high as half the detection limit.

Approach (1) above (non-detects = LOD) always produces a mean concentration which is biased high. Use of this method to predict the most probable exposure is not consistent with Region III's policy of using best science in risk assessments. Exposure assessors should use only approaches (2) or (3) (non-detects = 0 or LOD/2, respectively) to estimate most probable exposure. To minimize bias, the choice between (2) and (3) should be based on scientific judgment about whether the undetected substance might reasonably be present in that sample. The 3-step decision path below, followed by examples of appropriate selections, is recommended:

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Examples:

Step 1:

(a) 50 $\mu\text{g/l}$ TCE (a hazardous concentration) is present in groundwater on site. Continue.

(b) Highest measured TCE concentration in 20 samples from on-site wells is 2 $\mu\text{g/l}$. TCE is not an indicator chemical. Assume non-detects = 0.

Step 2:

(a) High TCE concentrations are measured upgradient of a residential well. TCE is not detected in the residential well itself. Continue.

(b) A residential well is upgradient of the site. Background TCE is not detectable. Treat this residential well sample as background, and average it only with other background samples. Assume non-detects = 0.

Step 3:

(a) Although TCE is not detected in the residential well, other site-related solvents are. Since these contaminants have solubilities and organic carbon/ water partitioning coefficients similar to TCE, TCE may reasonably be present in the samples. Assume non-detects = LOD/2.

(b) Neither TCE nor other solvents are detected in the residential wells. Assume non-detects = 0.

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APPENDIX:

Excerpts from
Proposed Guidelines for Exposure-Related Measurements

US EPA Risk Assessment Forum
30 September 1988

I. Reporting Data Near the Detection Limit

"Often times, extrapolation methodologies applied to toxicological studies result in acceptable risk levels which necessitate measuring environmental concentrations at or near the limit of detection (LOD). The limit of detection is defined as the lowest concentration level that can be determined to be statistically different from a blank (American Chemical Society, 1983). Data measured at or near the detection limit have considerably more uncertainty associated with them than when measurable amounts are present. To understand what a reasonably certain measure or a reliable detection is, the exposure assessor must understand the method of measurement as well as the statistical approach that was used to calculate the limit of detection..."

"The limit of detection (LOD) is the smallest concentration or amount of a substance that can be reliably detected by a given measurement process. The limit of quantitation (LOQ) is the smallest concentration or amount of a substance for which quantitative results may be obtained with a specified degree of confidence. The precise interpretation of these definitions depends on the analytical method... The American Chemical Society recommendation sets the LOD at 3 standard deviation units above the mean value of the blank responses and the LOQ at 10 standard deviations above the blank responses..."

"The exposure assessor should ensure that the LOD and LOQ have been clearly defined and estimated for the measurement process under consideration and are appropriate for the needs of the exposure assessment. The laboratory should not only state numerical values, but definitions of the LOD and LOQ... If the exposure assessor reports individual values, the American Chemical Society's Committee on Environmental Improvement (1983) recommends that:

- "1. If the measured value is less than the limit of detection, report "not detected" together with the value for the LOD.
- "2. If the measured value is larger than the LOD but smaller than the limit of quantification (LOQ), report "detected but not quantifiable" together with the value for the LOQ. The LOQ is the level above which quantitative results can be obtained with a specified degree of confidence.
- "3. If the measured value is greater than the LOQ, report the value and its uncertainty."

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II. Calculating Upper Bound and Most Probable Estimates of Chemical Concentrations

"The evaluation of both the mean and the dispersion of a data set depends on the knowledge or assumption of the type of distribution of the population. Types range from a uniform distribution in which all individuals have the same frequency of occurrence (e.g., flipping a coin) to those in which the frequencies of occurrence vary and may be symmetrically or asymmetrically distributed. The normal distribution is the type most frequently encountered and is familiar to most scientists. The results of measurement processes are often normally distributed. Individual samples from environmental media often exhibit a log-normal distribution. Log-normal data can be transformed to normal data by first converting to logarithms and then treating the logarithms as if they were the actual data. It would be useful to graph the available data to ensure that the results are normally distributed. There are computerized statistics packages on the commercial market which facilitate the determination of data distribution. Also, a limited number of samples may preclude statistical analysis of the data.

"Depending on the distribution of data, statistics such as dispersion, range, standard deviation, and confidence intervals can be developed, as well as measures of bias and uncertainty. ...the exposure assessor is advised to consult a statistician or good statistics text for further information and guidance in this area."

III. Selecting Observations to Include in Averages

"At some sites, background chemical contamination is significant and should be accounted for. Background is defined as chemical contamination due to a source other than the site under investigation. Background can be either natural or from man-made sources. The exposure assessor should try to define local background conditions of concern by observing nearby locations clearly unaffected by the site under investigation.

"When differences between a background (control site) and a target site are to be determined experimentally, the sampling of the control site must be done with the same detail and care as for that of the target. Otherwise, the uncertainty of any difference can be limited by the data for the control."

IV. Calculating Averages Which Include Non-Detects

"Exposure assessors may often be faced with data consisting largely of "below LOD" or "at LOD" values. Since the exposure assessment is only as good as the data supporting it, it is essential to interpret these types of data properly so as to avoid misrepresenting the data set or the exposure assessment itself. Rules of thumb that the exposure assessor may encounter in the way

data sets are reported include....:

- "1. All Non-Detects reported as LODs - In this worst-case approach, all non-detects are assigned the value of the LOD, which may be considered the largest concentration of analyte that could be present but not yet detected. This approach biases the mean in a positive direction. The seriousness of such a bias will depend on the relative number of detects and non-detects in the data set and the relative size of the detection limit compared to the mean of the data with values above the LOD.
- "2. All Non-Detects reported as zero - This approach results in biasing the mean in a negative direction. Again, the seriousness of the bias depends on the relative number of detects and non-detects and the mean of the data with values above zero.
- "3. All Non-Detects as LOD/2 - This approach assumes that on the average all values between the LOD and zero could be present; therefore, an average value would result if many samples in this range were measured. Similar to the above approaches, the seriousness of the bias depends on the relative number of detects and non-detects and the mean of the data above LOD/2."

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